

1 Human Exposure Assessment

1.1 Maximum Permissible Exposure

1.1.1 Limit of Maximum Permissible Exposure

Limits for Occupational / Controlled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-3.0	614	1.63	(100)*	6
3.0-30	1842 / f	4.89 / f	(900 / f)*	6
30-300	61.4	0.163	1.0	6
300-1500	-	-	F/300	6
1500-100,000	-	-	5	6
Limits for General Population / Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/ cm ²)	Averaging Time E ² , H ² or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f)*	30
30-300	27.5	0.073	0.2	30
300-1500	-	-	F/1500	30
1500-100,000	-	-	1.0	30
Note 1: f = frequency in MHz ; *Plane-wave equivalent power density				
Note 2: For the applicable limit, see FCC 1.1310				

RF Field Strength Limits for Controlled Use Devices (Controlled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1	600	4.9	-	6
1-10	600/ <i>f</i>	4.9/ <i>f</i>	-	6
10-30	60	4.9/ <i>f</i>	-	6
30-300	60	0.163	10*	6
300-1500	3.54 <i>f</i> 0.5	0.0094 <i>f</i> 0.5	<i>f</i> /30	6
1500-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ <i>f</i> 1.2
150000-300000	0.354 <i>f</i> 0.5	9.4 x 10 ⁻⁴ <i>f</i> 0.5	3.33 x 10 ⁻⁴ <i>f</i>	616000/ <i>f</i> 1.2
RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	280/ <i>f</i>	2.19/ <i>f</i>	-	6
10-30	28	2.19/ <i>f</i>	-	6
30-300	28	0.073	2*	6
300-1500	1.585 <i>f</i> ^{0.5}	0.0042 <i>f</i> ^{0.5}	<i>f</i> /150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ <i>f</i> ^{1.2}
150000-300000	0.158 <i>f</i> ^{0.5}	4.21 x 10 ⁻⁴ <i>f</i> ^{0.5}	6.67 x 10 ⁻⁵ <i>f</i>	616000/ <i>f</i> ^{1.2}
Note 1: <i>f</i> is frequency in MHz.				
Note 2: For the applicable limit, see IC RSS-102				

1.1.2 MPE Calculation Method

$$E \text{ (V/m)} = \frac{\sqrt{30 \times P \times G}}{d}$$

E = Electric field (V/m)

G = EUT Antenna numeric gain (numeric)

The formula can be changed to

$$Pd = \frac{30 \times P \times G}{377 \times d^2}$$

$$\text{Power Density: } Pd \text{ (W/m}^2\text{)} = \frac{E^2}{377}$$

P = RF output power (W)

d = Separation distance between radiator and human body (m)

1.1.3 Result of Maximum Permissible Exposure - (Antenna Gain :13dBi)

Transmitter Chains & Receiver Chains Information				
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N _{TX})	Number of Receive Chains (N _{RX})	Correlation Signals with Multiple N _{TX}	RF Output Power (dBm)
a	1	1	Correlated	22.33
n(HT20)	2	2	Uncorrelated	24.67
n(HT40)	2	2	Uncorrelated	24.73
ac(VHT20)	2	2	Uncorrelated	24.78
ac(VHT40)	2	2	Uncorrelated	24.80
ac(VHT80)	2	2	Uncorrelated	24.67

Note 1: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.)

Note 2: RF output power specifies that Maximum Conducted (Average) Output Power.

Worst Maximum RF Output Power Result							
Exposure Environment		Controlled Use Devices (Controlled Environment)					
Separation Distance (cm)		120					
Power Level	1	RF Output Power (dBm)					
Modulation Mode	N _{TX}	Chain-Port 1	Chain-Port 2	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
a	1	-	22.33	22.33	13	35.33	0.01886
n(HT20)	2	20.59	22.52	24.67	13	37.67	0.03229
n(HT40)	2	20.58	22.61	24.73	13	37.73	0.03275
ac(VHT20)	2	20.63	22.67	24.78	13	37.78	0.03318
ac(VHT40)	2	20.60	22.73	24.80	13	37.80	0.03332
ac(VHT80)	2	20.52	22.56	24.67	13	37.67	0.03229
Maximum Permissible Exposure Limit (mW/cm²)							5

Note 1: N_{TX} = Number of Transmit Chains

1.1.4 Result of Maximum Permissible Exposure - (Antenna Gain :20dBi)

Transmitter Chains & Receiver Chains Information				
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N _{TX})	Number of Receive Chains (N _{RX})	Correlation Signals with Multiple N _{TX}	RF Output Power (dBm)
a	1	1	Correlated	24.40
n(HT20)	2	2	Uncorrelated	24.99
n(HT40)	2	2	Uncorrelated	24.73
ac(VHT20)	2	2	Uncorrelated	24.87
ac(VHT40)	2	2	Uncorrelated	24.80
ac(VHT80)	2	2	Uncorrelated	24.67

Note 1: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.)

Note 2: RF output power specifies that Maximum Conducted (Average) Output Power.

Worst Maximum RF Output Power Result							
Exposure Environment		Controlled Use Devices (Controlled Environment)					
Separation Distance (cm)		120					
Power Level	1	RF Output Power (dBm)					
Modulation Mode	N _{TX}	Chain-Port 1	Chain-Port 2	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
a	1	-	24.40	24.40	20	44.40	0.15223
n(HT20)	2	20.85	22.89	24.99	20	44.99	0.17453
n(HT40)	2	20.58	22.61	24.73	20	44.73	0.16414
ac(VHT20)	2	20.83	22.69	24.87	20	44.87	0.16976
ac(VHT40)	2	20.60	22.73	24.80	20	44.80	0.16698
ac(VHT80)	2	20.52	22.56	24.67	20	44.67	0.16185
Maximum Permissible Exposure Limit (mW/cm ²)							5

Note 1: N_{TX} = Number of Transmit Chains

1.1.5 Result of Maximum Permissible Exposure - (Antenna Gain :34dBi)

Transmitter Chains & Receiver Chains Information				
IEEE Std. 802.11 Protocol	Number of Transmit Chains (N _{TX})	Number of Receive Chains (N _{RX})	Correlation Signals with Multiple N _{TX}	RF Output Power (dBm)
a	1	1	Correlated	24.40
n(HT20)	2	2	Uncorrelated	24.99
n(HT40)	2	2	Uncorrelated	24.73
ac(VHT20)	2	2	Uncorrelated	24.87
ac(VHT40)	2	2	Uncorrelated	24.80
ac(VHT80)	2	2	Uncorrelated	24.67

Note 1: Co-location, Co-location is generally defined as simultaneously transmitting (co-transmitting) antennas within 20 cm of each other. (i.e., EUT has simultaneously co-transmitting that operating 2.4GHz and 5GHz.)

Note 2: RF output power specifies that Maximum Conducted (Average) Output Power.

Worst Maximum RF Output Power Result							
Exposure Environment		Controlled Use Devices (Controlled Environment)					
Separation Distance (cm)		120					
Power Level	1	RF Output Power (dBm)					
Modulation Mode	N _{TX}	Chain-Port 1	Chain-Port 2	Sum Chain	Gain (dBi)	EIRP Power	PD (S) (mW/cm ²)
a	1	-	24.40	24.40	34	58.40	3.82388
n(HT20)	2	20.85	22.89	24.99	34	58.99	4.38391
n(HT40)	2	20.58	22.61	24.73	34	58.73	4.12293
ac(VHT20)	2	20.83	22.69	24.87	34	58.87	4.26408
ac(VHT40)	2	20.60	22.73	24.80	34	58.80	4.19438
ac(VHT80)	2	20.52	22.56	24.67	34	58.67	4.06545
Maximum Permissible Exposure Limit (mW/cm ²)							5

Note 1: N_{TX} = Number of Transmit Chains